INDOOR AIR QUALITY ASSESSMENT

Crowell Elementary School
26 Belmont Ave
Haverhill, Massachusetts 01830

Prepared by:
Massachusetts Department of Public Health
Center for Environmental Health
Bureau of Environmental Health Assessment
Emergency Response/Indoor Air Quality Program
June 2004

Background/Introduction

At the request of Jeffrey Dill, Supervisor of Maintenance and Energy Management, Haverhill Public Schools (HPS), the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA) provided assistance and consultation regarding indoor air quality concerns at the Crowell Elementary School (CES), Haverhill, Massachusetts. The request was prompted by concerns of mold resulting from chronic water damage. On November 21, 2003, a visit to conduct an indoor air quality assessment was made to the CES by Michael Feeney, Director of BEHA's Emergency Response/Indoor Air Quality (ER/IAQ) Program and Sharon Lee, Environmental Analyst, ER/IAQ Program.

The CES is a two-story brick building constructed in 1891. The eight-room facility underwent renovations in the 1980s. Classrooms are located on the first and second floor. The nurse's office and other office spaces are located on the first floor. The basement consists of an art room, a music room, library, and cafeteria. Windows throughout the building are openable.

As previously mentioned, the CES has a history of chronic water damage. HPS staff attribute water penetration to the age of the roof and conditions of the gutter/downspout system. Over time, the severity of water penetration to the building has reportedly increased. Following heavy spring rains in 2003, much of the building interior, especially basement rooms, became water damaged. According to CES staff, the basement areas would flood during rainstorms. Because of the severity of water damage experienced and the concerns raised at the CES, HPS hired a consultant, HUB Testing Laboratory, Inc. (HUB), to conduct mold testing. HUB performed sampling on September 24, 2003. In their assessment, HUB identified areas with visible water damage. After receiving the HUB report, CES restricted basement areas from use and began working with a roofing company to repair the roof and replace the gutter system. Roof repairs began October 30, 2003. At the time of the MDPH IAQ assessment, the roof repairs were complete and basement areas were under renovation. At the time of this assessment, HPS maintenance staff were cleaning/removing plaster surfaces and replacing wood molding and plaster ceilings.

Methods

BEHA staff performed visual inspection of building materials for water damage and/or microbial growth. Air tests for carbon monoxide, carbon dioxide, temperature and relative humidity were conducted with the TSI, Q-Trak, IAQ Monitor, Model 8551. Air tests for airborne particle matter with a diameter less than 2.5 micrometers were taken with the TSI, DUSTTRAK™ Aerosol Monitor Model 8520. Screening for total volatile organic compounds (TVOCs) was conducted using a Thermo Environmental Instruments Inc., Model 580 Series Photo Ionization Detector (PID). Moisture content of water damaged wooden trim was measured with a Delmhorst, BD-2000 Model, Moisture Detector equipped with a Delmhorst Standard Probe.

Results

The school houses approximately 130 students in kindergarten through second grade and has a staff of approximately 10. Tests were taken during normal operations and results appear in Table 1.

Discussion

Ventilation

It can be seen from Table 1 that carbon dioxide levels were above 800 parts per million of air (ppm) in twelve of sixteen areas surveyed, indicating inadequate ventilation in many areas of the school. At the time of the assessment, no mechanical ventilation was operating. Windows throughout the building were closed.

Fresh air in classrooms of these sections of the building was originally supplied by a unit ventilator (univent) system (Picture 1). Univents are designed to draw air from outdoors through a fresh air intake located on the exterior walls of the building (Picture 2) and return air through an air intake located at the base of each unit (Figure 1). Univents were deactivated in all classrooms throughout the school. Obstructions to airflow, such as furniture located in front of and/or materials stored on univents, were observed (Picture 3). In order for univents to provide fresh air as designed, these units must remain activated and allowed to operate while rooms are occupied. In addition, air diffusers and return vents must remain free of obstructions. Due to the age and condition of the univent system, it may not be feasible to reactivate the univents without a complete refurbishment or replacement. Open windows seems to be the only viable way to introduce fresh air into classrooms.

Exhaust ventilation was originally provided by a gravity exhaust ventilation system. Exhaust ventilation is created through the rising of hot air. Typically, a heating element is located at the bottom of the airshaft. Air warmed by the heating element rises up the airshaft, which then draws air from the each room into the shaft via grated floor or wall vents (Picture 4). Operation of univents would also provide slight positive pressure, moving air towards the grated exhaust vents. Once classroom air enters the exhaust shaft, it moves upwards and exits the building. According to maintenance staff, the gravity exhaust system has been deactivated. All of the floor grates on the first floor had been sealed and refinished (Picture 5). Wall grates on the second floor remain open; however, many are currently blocked (Picture 6).

To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy. In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. The date of the last balancing of these systems was not available at the time of the assessment. It is recommended that HVAC systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994).

The Massachusetts Building Code requires that each room have a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens, a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week, based on a time-weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, see Appendix A.

Indoor temperature measurements ranged from 66° F to 72° F, which were close to the BEHA recommended comfort range in most classrooms. The BEHA recommends that indoor air temperatures be maintained in a range of 70° F to 78° F in order to provide for the comfort of building occupants. A number of temperature control complaints were expressed to BEHA staff. It is difficult to control temperature and maintain comfort in a building without operating the HVAC equipment as designed (e.g. univents deactivated/exhaust not functioning). In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

Indoor relative humidity measurements ranged from 41 to 52 percent, which was within the BEHA recommended comfort range in all areas assessed. The BEHA recommends a comfort range of 40 to 60 percent for indoor air relative humidity. Relative humidity levels in the building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

As previously discussed, the school has a history of water damage problems. According to staff, the conditions of the roof and gutter system allowed for water to penetrate the building. During the MDPH assessment, BEHA staff members conducted an inspection of the building exterior and noted the conditions of the gutter and drain systems. In its original design, the gutter system would collect and move water towards drains that moved water down and away from the building. However, the original gutter and drain system is no longer intact. This condition allowed water to flow against the building. Water running against the building has caused discoloration to the building exterior and damage to brick and mortar (Picture 7). Mortar was also eroded in other portions of the building (Picture 8). At the time of the assessment, Haverhill school officials indicated that the roof and gutter system had been replaced. BEHA staff noted the drainage system replacement (Picture 9).

At the time of the assessment, maintenance staff were in the process of repairing water damaged components in the school. Water damaged ceiling material in the cafeteria had been replaced (Picture 10) and the art room was under renovations (Picture 11). BEHA staff examined the exterior facing walls of the art room for water damage. Moisture readings of water damaged wall materials were also taken with a Delmhorst, BD-2000 Model, Moisture Detector with a Delmhorst Standard Probe. The Delmhorst probe is equipped with three lights that serve as visual representations of moisture level. Materials that activate the green light indicate a sufficiently dry level (0 - 0.5%), those that activate the yellow light indicate borderline conditions (0.5 – 1.0%) and those that activate the red light indicate elevated moisture content (> 1%). The probe was inserted into water-damaged wood located between the wall and a bookshelf along windows in the art room. Elevated moisture levels were measured in the wood, indicating that it was moistened from water penetration through art room window frames (Picture 12).

Other points of water penetration were also noted. The doorway between the art room and library is another point where water is penetrating into the building. The doorframe and wall show signs of water damage (Picture 13).

Breaches were also noted around window frames. Caulking around windows was missing/damaged. Missing caulking can make temperature control difficult and allow water to penetrate the building. Replacement of caulking and repairs of window leaks are necessary to prevent water penetration and subsequent damage to building materials, which can lead to mold growth. Ceiling plaster on both the first and second floor showed signs of historic water damage.

The location of the water damaged plaster indicates rainwater leakage through window frames, water infiltration through fresh air intakes of univents or steam pipe leaks. Wall plaster is not a good mold growth medium, however, water trapped behind wallpaper or paint can become a vehicle for mold growth.

Shrubbery and other plants were growing in close proximity to foundation walls (Picture 14). The growth of roots against the exterior walls can bring moisture in contact with wall brick. Plant roots can eventually penetrate the brick, leading to cracks and/or fissures in the below ground level foundation. Over time, this process can undermine the integrity of the building envelope, providing a means of water entry into the building through foundation concrete and masonry by capillary action (Lstiburek & Brennan, 2001).

Lastly, plants were located on windowsills or near windows in several classrooms. Some plants were found on top of univents (Picture 15). Plants, soil and drip pans can serve as sources of mold growth, thus should be properly maintained. Over-watering of plants should be avoided and drip pans should be inspected periodically for mold growth. Plants should also be located away from univents and ventilation sources to prevent aerosolization of dirt, pollen or mold.

Other Concerns

Indoor air quality can be negatively influenced by the presence of respiratory irritants, such as products of combustion. The process of combustion produces a number of pollutants, where the pollutant produced is dependent on the material combusted. Common combustion emissions include carbon monoxide, carbon dioxide, water vapor and smoke (fine airborne particulate matter). Of these materials, exposure to carbon monoxide and particulate matter with a diameter of 2.5 micrometers (μm) or less (PM2.5) can produce immediate, acute health effects upon exposure. To determine whether combustion products were present in the school environment, BEHA staff obtained measurements for carbon monoxide and PM2.5 during the November 21, 2003 visit.

Carbon monoxide is a by-product of incomplete combustion of organic matter (e.g., gasoline, wood and tobacco). Exposure to carbon monoxide can produce immediate and acute health affects. Several air quality standards have been established to address carbon monoxide and prevent symptoms from exposure. The MDPH established a corrective action level concerning carbon monoxide in ice skating rinks that use fossil-fueled ice resurfacing equipment. If an operator of an indoor ice rink measures a carbon monoxide level over 30 ppm, taken 20 minutes after resurfacing within a rink, that operator must take actions of reduce carbon monoxide levels (MDPH, 1997).

ASHRAE has adopted the National Ambient-Air Quality Standards (NAAQS) as one set of criteria for assessing indoor air quality and monitoring of fresh air introduced by HVAC systems (ASHRAE, 1989). The NAAQS are standards established by the US EPA to protect the public health from 6 criteria pollutants, including carbon monoxide and particulate matter (US EPA, 2000). As recommended by ASHRAE, pollutant levels of fresh air introduced to a building should not exceed the NAAQS (ASHRAE, 1989). The NAAQS were adopted by reference in the Building Officials & Code Administrators (BOCA) National Mechanical Code of 1993 (BOCA, 1993), which is now an HVAC standard included in the Massachusetts State Building Code (SBBRS, 1997). According to the NAAQS, carbon monoxide levels in the outdoor air should not exceed 9 ppm in an eight-hour average (US EPA, 2000).

Carbon monoxide should not be present in a typical, indoor environment. If it *is* present, indoor carbon monoxide levels should be less than or equal to outdoor levels. Outdoor carbon monoxide concentrations were non-detectable (ND) (Table 1). Carbon monoxide levels measured in the school were also ND.

Particulate matter is airborne solids that can be irritating to the eyes, nose and throat. The US EPA also established NAAQS limits for exposure to particulate matter. The NAAQS originally established exposure limits to particulate matter with a diameter of 10 μm or less (PM10). According to the NAAQS, PM10 levels should not exceed 150 microgram per cubic meter ($\mu g/m^3$) in a 24-hour average (US EPA, 2000). These standards were adopted by both ASHRAE and BOCA. Since the issuance of the ASHRAE standard and BOCA Code, US EPA proposed a more protective standard for fine airborne particles. This more stringent, PM2.5 standards requires outdoor air particle levels be maintained below 65 $\mu g/m^3$ over a 24-hour average (US EPA, 2000). Although both the ASHRAE standard and BOCA Code adopted the PM10 standard for evaluating air quality, BEHA uses the more protective proposed PM2.5 standard for evaluating airborne particulate matter concentrations in the indoor environment.

Outdoor PM2.5 concentrations were measured at 30 $\mu g/m^3$ (Table 1). In some areas, PM2.5 levels measured in the school were above outdoor levels, but did not exceed the NAAQS. A number of mechanical devices and/or activities that occur in schools can generate particulate during normal operations. Sources of indoor airborne particulates may include but are not limited to particles generated during the operation of fan belts in the HVAC system, cooking in the cafeteria stoves and microwave ovens; use of photocopiers, fax machines and computer printing devices; operation of an ordinary vacuum cleaner and heavy foot traffic indoors. As previously discussed, neither mechanical supply nor exhaust were operating at the school at the time of the assessment. Without the operation of mechanical ventilation systems, a buildup of common indoor air pollutants can occur. Moreover, the basement art room was undergoing renovations at the time of assessment. Renovations activities can also contribute to elevated PM2.5 levels.

Indoor air quality can also be negatively influenced by the presence of materials containing volatile organic compounds (VOCs). VOCs are carbon-containing substances that have the ability to evaporate at room temperature. Frequently, exposure to low levels of total VOCs (TVOCs) may produce eye, nose, throat and/or respiratory irritation in some sensitive individuals. For example, chemicals evaporating from a paint can stored at room temperature would most likely contain VOCs. In an effort to determine whether VOCs were present in the building, air monitoring for TVOCs was conducted during the November 21, 2003 visit. An outdoor air sample was taken for comparison. Outdoor TVOC concentrations were ND (Table 2). Indoor TVOC concentrations were also ND.

In an effort to identify materials that can potentially increase indoor TVOC concentrations, BEHA staff examined classrooms for products containing these respiratory irritants. Please note, TVOC air measurements are only reflective of the indoor air concentrations present at the time of sampling. Indoor air concentrations can be greatly impacted by the use of TVOC containing products. While no TVOC measurements exceeded background levels, materials containing VOCs were present in the school.

Several classrooms contained dry erase boards, dry erase cleaners, and dry erase board markers. Materials such as dry erase markers and dry erase board cleaners may contain VOCs, such as methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve (Sanford, 1999), which can be irritating to the eyes, nose and throat.

Cleaning products were found on countertops, in unlocked cabinets beneath sinks, and on shelves in some classrooms (Picture 16). Like dry erase materials, cleaning products contain VOCs and other chemicals that can be irritating to the eyes, nose and throat of sensitive individuals. Also of concern are unlabelled bottles and containers located under sink cabinets.

Products should be kept in their original containers or the contents should be clearly labeled for identification purposes, especially in the event of an emergency.

In an effort to reduce noise from sliding chairs, tennis balls had been sliced open and placed on chair legs. Tennis balls are made of a number of materials that are a source of respiratory irritants. Constant wearing of tennis balls can produce fibers and off-gas VOCs. Tennis balls are made with a natural rubber latex bladder, which becomes abraded when used as a chair leg pad. Use of tennis balls in this manner may introduce latex dust into the school environment. Some individuals are highly allergic to latex (e.g., spina bifida patients) (SBAA, 2001). It is recommended that the use of materials containing latex be limited in buildings to reduce the likelihood of symptoms in sensitive individuals (NIOSH, 1997). A question and answer sheet concerning latex allergy is attached as Appendix B (NIOSH, 1998).

Other conditions that can affect indoor air quality were noted during the assessment. Pathways exist for boiler room odors and other materials to move into occupied areas. The boiler room can be accessed through a long, narrow hallway in the basement (Picture 17). There is no door separating the boiler room hallway from other portions of the basement. This allows for odors and materials from this room to move into other portions of the basement. Furthermore, a food service elevator is located at the entrance to the doorway of the boiler room (Picture 18). The elevator shaft can serve as a mechanism for odors and particles to move into upper level areas.

Food was apparently used in a number of art projects (Picture 19 and Picture 20). Food is an attractant to pests and rodents. Proper food storage is an integral component in maintaining indoor air quality. Food should be properly stored and clearly labeled. Moreover, food should be placed away from cleaning products, in separate storage areas. Reuse of food containers is not recommended, since food residue adhering to the surface may serve as an attractant to pests.

Accumulated chalk dust was noted in some classrooms. Chalk dust is a fine particulate that can easily become aerosolized. Once aerosolized, chalk dust can become irritating to eyes and the respiratory system. Similarly, pencil shavings were observed to be accumulating at the base of pencil sharpeners. When windows are opened, pencil shavings can become airborne, providing a source of eye and respiratory irritation.

Also of note was the amount of materials stored inside classrooms. In classrooms throughout the school, items were observed on windowsills, tabletops, counters, univents, bookcases and desks. The stored materials (e.g., papers, folders, boxes) in classrooms provide surfaces for dust to accumulate. Accumulation of these items makes cleaning difficult for custodial staff. Dust can be irritating to eyes, nose and respiratory tract.

Conclusions/Recommendations

Remediation efforts to install new gutter and downspouts on the building will prevent further water damage to the school. Such efforts will also serve to remove water damaged building components and prevent potential mold growth media in the building. In addition to these efforts, BEHA staff makes the following recommendations:

1. Continue with remediation efforts in the basement areas.
2. Consider consulting a heating, ventilation and air conditioning (HVAC) engineer concerning the operability of univents. Consideration should be given to replacing univents.
3. Consider re-establishing a functional exhaust ventilation system for classrooms, if univents are to be replaced.

4. Use openable windows to create air exchange. Care should be taken to ensure windows are properly closed at night and weekends to avoid the freezing of pipes and potential flooding.
5. Consider repointing brickwork.
6. Operate all ventilation systems that are operable throughout the building (e.g., gym, auditorium, classrooms) continuously during periods of school occupancy and independent of thermostat control to maximize air exchange.
7. Adopt scrupulous cleaning practices. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Avoid the use of feather dusters. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).
8. Ensure plants have drip pans. Examine drip pans periodically for mold growth and disinfect with an appropriate antimicrobial where necessary. Keep plants away from the air stream.
9. Relocate or consider reducing the amount of materials stored in classrooms to allow for more thorough cleaning of classrooms. Clean items regularly with a wet cloth or sponge to prevent excessive dust build-up.
10. Clean chalkboard/dry erase marker trays regularly to prevent the build-up of excessive chalk dust and particulate.
11. Store cleaning products properly and out of reach of students.

12. Consider adopting the US EPA document, “Tools for Schools”, to maintain a good indoor air quality environment on the building. This document can be downloaded from the Internet at: http://www.epa.gov/iaq/schools/index.html.
13. Refer to resource manuals and other related indoor air quality documents for further building-wide evaluations and advice on maintaining public buildings. These materials are located on the MDPH’s website at http://www.state.ma.us/dph/beha/iaq/iaqhome.htm.

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Picture 1

Classroom univent

Picture 2

Exterior fresh air intake

Picture 3

Univent disguised as fireplace and blocked by aluminum cans

Picture 4

Grated wall exhaust

Picture 5

Sealed floor exhaust

Picture 6

Blocked grated wall exhaust

Picture 7

Damaged and discolored brickwork

Picture 8

Eroded mortar on building exterior (Pen Insert by BEHA staff to show size of space in mortar)

Picture 9

Roof drain installed prior to assessment

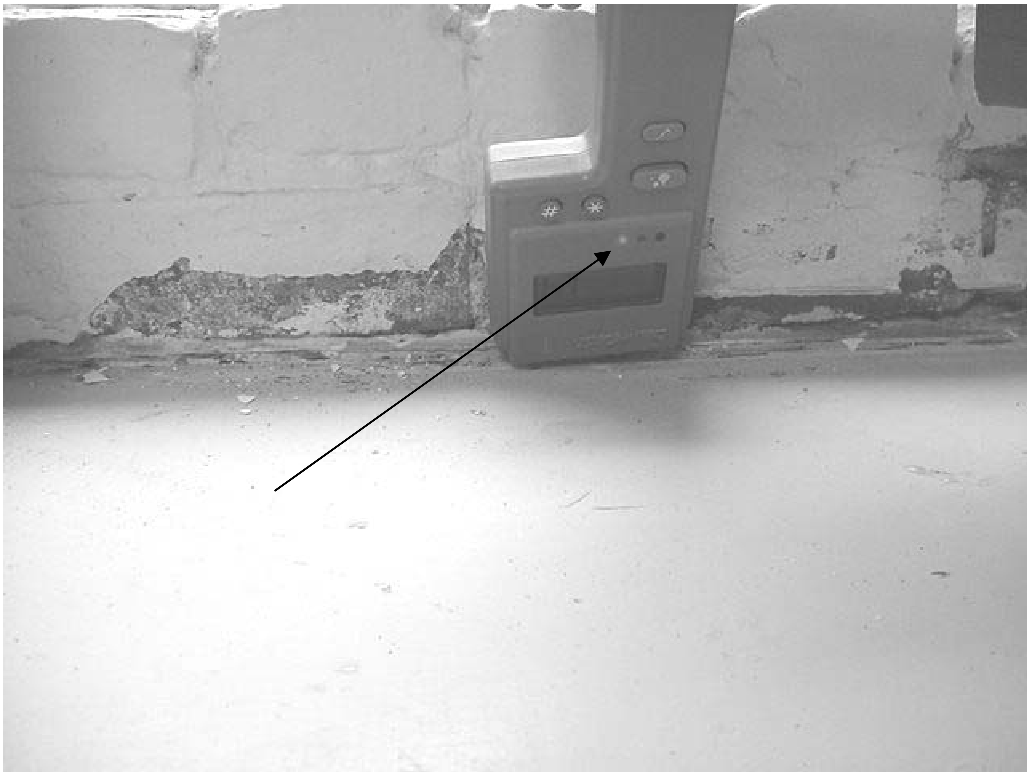
Picture 10

New gypsum wallboard ceiling in cafeteria

Picture 11

Art room under renovation

Picture 12



Moisture meter with red light lit

Picture 13

Water damaged wall and door frame

Picture 14

Plants growing in creak between wall and ground

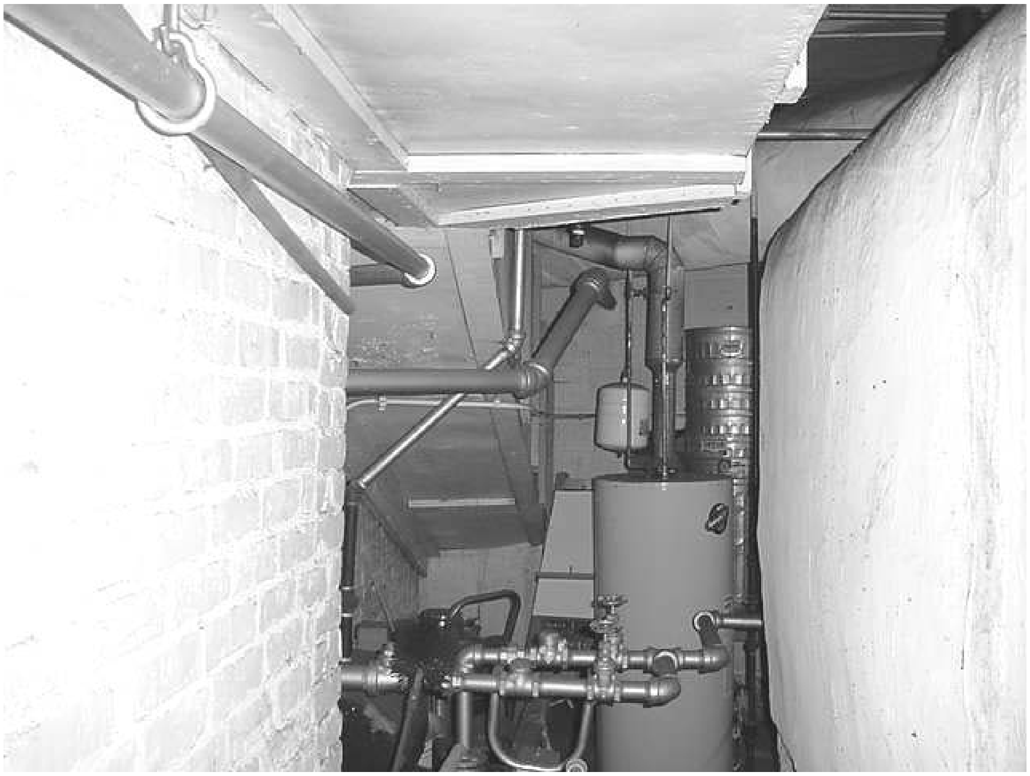
Picture 15

Plants growing on top of univent, near window

Picture 16

Cleaners and food containers stored in bookcase

Picture 17



Hallway to boiler room

Picture 18

Service box in boiler room hallway

Picture 19

Food art

Picture 20

Pasta necklaces

Crowell Elementary School | **Indoor Air Results**

Haverhill, MA 01830 | **November 21, 2003**

Table 1

Location/ Room	Carbon Dioxide (*ppm)	Temp (°F)	Relative Humidity (%)	Carbon Monoxide (*ppm)	TVOCs (*ppm)	PM2.5 (µg/m3)	Occupants in Room	Windows Openable	Ventilation Supply	Ventilation Exhaust	Remarks
Background (outdoors)	295	55	46	ND	ND	30	-	-	-	-	Overcast, NW wind ~5 mph
Room 8	1216	69	44	ND	ND	39	18	Y	Y Off	Y Off	Hallway and Inter-room DO; Clutter and furniture blocking univent; clutter blocking exhaust; CD; plants; clutter; peeling ceiling paint; dry ears of corn; standing water in pitcher
Room 7	963	69	42	ND	ND	30	0	Y	Y Off	Y Off	Hallway and Inter-room DO; Univent side panel open; univent and exhaust occluded with dirt/debris; CD; DEM; dusty window
Room 6	1273	69	45	ND	ND	40	10	Y	Y Off	Y Off	Hallway and Inter-room DO; Supply and exhaust blocked by clutter and occluded with dirt/debris; CD; permanent markers; food use/storage; dry ears of corn; WD ceiling plaster; commercial cleaners, paint, and spray

ppm = parts per million parts of air

µg/m3 = microgram per cubic meter

AD = air deodorizer
AHU = air-handling unit
AP = air purifier
AC = air conditioning
AT = ajar tile
CD = chalk dust

CT= ceiling tile
DEM = dry erase marker
DO = door open
MT= missing ceiling tile
PC = photocopier

PF = personal fan
TB = tennis balls
UF = upholstered furniture
WD = water damage
ND = non-detect

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

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									Supply	Exhaust	
											glue in storage closet
Reading corner	1054	70	44	ND	ND	40	2	Y	N	N	Hallway and Inter-room DO; DEM; WD ceiling plaster
Second floor Hallway	-	-	-	-	-	-	-	-	-	-	Food use - popcorn seeds and, corn stalks, ears of corn; breach between sink and counter
Room 5	1152	67	46	ND	ND	40	0	Y	Y Off	Y Off	Hallway and Inter-room DO; Univent and exhaust occluded with dirt/debris; PF; DEM; WD ceiling plaster; buffet range
Room 4	1317	69	44	ND	ND	40	14	Y	Y Off	N	Hallway DO; Univent blocked with clutter and occluded with dirt and debris; DEM; food storage/use; dust; clutter; cleaners; terrarium
Room 2	2401	69	47	ND	ND	50	22	Y	Y	N	Hallway DO; Univent occluded with dirt/debris and blocked by plants and clutter;

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									Supply	Exhaust	
									Off		CD; PF; food storage/use (coffee cans, pasta jewelry, milk cartons); pencil shavings; spray shellac; WD wall plaster and ceiling plaster
Room 3	1164	68	49	ND	ND	30	16	Y	Y OFF	N	Hallway and Inter-room DO; Univent occluded with dirt/debris and blocked by clutter; DEM; dust; clutter; cleaners; food storage/use
Room 1	3320	69	52	ND	ND	60	22	Y	Y	N Off	Inter-room DO; Univent blocked by clutter and occluded with dirt/debris; TB; DEM; clutter; cleaners; WD ceiling plaster
Nurse's Office	712	69	42	ND	ND	20	0	Y	N	N	Hallway DO
Secretary 's Office	1729	68	43	ND	ND	34	0	N	N	N	Hallway DO; PF; cleaners

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									Supply	Exhaust	
Eyes and Ears office	953	69	42	ND	ND	40	0	Y	N	N	Hallway DO; Paint can; air deodorizer; dust; PF
Library	562	68	41	ND	ND	20	0	Y	N	N	WD ceiling plaster; CD; dust; clutter; breaches around pipes; spaces around window frames; WD window frames
Art/Library Hallway		-	-	-	-	-	-	-	-	-	WD exterior door frame
Art room	584	66	44	ND	ND	60	0	Y	N	N	Under renovations: WD window sills; WWD wall plaster; WD ceiling plaster; efflorescence
Cafeteria	1303	71	50	ND	ND	30	40	Y	N	N	Repairing WD ceiling plaster
Teachers' Lounge	634	72	43	ND	ND	20	2	Y	N	N	Laminator; refrigerator; soda machine

ppm = parts per million parts of air

μg/m3 = microgram per cubic meter

AD = air deodorizer
AHU = air-handling unit
AP = air purifier
AC = air conditioning
AT = ajar tile
CD = chalk dust

CT= ceiling tile
DEM = dry erase marker
DO = door open
MT= missing ceiling tile
PC = photocopier

PF = personal fan
TB = tennis balls
UF = upholstered furniture
WD = water damage
ND = non-detect

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%